LANGAN
ENGINEERING & ENVIRONMENTAL SERVICES

Technical Memorandum

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To: C. David Brown P.G., PADEP

From: Emily Strake, Langan Project Chemist/Risk Assessor

CC: Jim Oppenheim, Evergreen Capital Holdings, LLC

Date: January 27, 2014

Re: **Development of Lead Attainment Standard**
PES Refinery Philadelphia and Marcus Hook Industrial Complex

The Pennsylvania Department of Environmental Protection (PADEP) published a nonresidential screening level for lead calculated on the basis of soil ingestion as presented in 25 Pa. Code § 250.306(e), Appendix A, Table 7. The nonresidential soil screening value was derived using the Society for Environmental Geochemistry and Health (SEGH) model, which was developed by the SEGH "Lead in Soil" Task Force (Wixson, 1991). In the SEGH model, a blood lead concentration (PbB) is equated to a baseline lead level plus an increment resulting from exposure to lead in soil or dust. The slope of the blood lead/environmental lead relationship used in calculating the increase in PbB over the baseline value, and, hence the soil screening level, can vary depending on a multitude of factors. The SEGH model permits adjustment of the target blood lead concentration (T), geometric mean background blood lead concentration (B), and geometric standard deviation of blood lead distribution (G) in consideration of site-specific conditions, but precludes adjustments on the basis of exposure and lead bioavailability. Based on the SEGH model and the PADEP's default parameters, the non-residential direct contact Medium Specific Concentration (MSC) for lead in shallow soil (0 - 2 feet) is 1,000 milligrams per kilogram (mg/kg).

The PADEP has endorsed the use of alternative uptake biokinetic models for the evaluation of lead toxicity (PADEP, 2013). Given that the Integrated Exposure Uptake Biokinetic (IEUBK) Model is intended for estimating child blood lead level concentrations and does not apply to adult exposure scenarios, the PADEP maintains:

> "For adult exposure in either the residential or nonresidential scenario… other models, such as the Bower [sic] model (Bowers *et al.*, 1994), or the physiologically-based pharmacokinetic model (O'Flaherty, 1995, 1997) developed to determine the effects of lead on adults may be used to determine site-specific cleanup numbers."

In response to the need for a scientifically defensible approach for assessing soil-borne human health lead risks at non-residential contaminated sites, the United States Environmental Protection Agency (EPA) adapted the Bowers *et al.* model to develop the Adult Lead Model (ALM) using the same basic algorithms. The ALM is a widely-accepted approach to risk characterization for commercial and industrial adult worker exposure scenarios. In 2001, the EPA conducted a review of six biokinetic adult lead models for assessing human health risk associated with non-residential exposure. The study concluded that no single model, including

the O'Flaherty model, represented a significant improvement to the ALM. Consequently, EPA recommended continued use of the ALM (EPA, 2001).

The ALM methodology is designed to estimate an average soil lead concentration that is not expected to result in a greater than 5% probability that the fetus of a female worker of child-bearing age has a blood lead level exceeding the level of concern of 10 micrograms per deciliter (µg/dL) of blood (EPA, 2003). This represents a conservative approach, as the PADEP applies a target blood lead level of 20 µg/dL as the default value in deriving the MSC for lead (PADEP, 1997). Further, a site-specific target blood lead level of 25 µg/dL was previously adopted for the PES Refinery and Marcus Hook Industrial Complex (personal communication, 2010).

The basis for the calculation of the blood lead concentration for female workers of child-bearing age is given by:

$$PbB_{adult,central,goal} = PbB_{adult,0} + \frac{PbS * BKSF * IR * AF * EF}{AT}$$

Where:

$PbB_{adult,\ central,\ goal}$ = Goal for central estimate of blood lead concentration
$PbB_{adult,0}$ = Typical blood lead concentration
PbS = Soil lead concentration (appropriate average concentration for individual)
BKSF = Biokinetic slope factor
IR = Intake rate of soil
AF = Absolute gastrointestinal absorption fraction
EF = Exposure frequency
AT = Averaging time

Given that the effects of lead are well understood, and the mean PbB is recognized as an acceptable predictor of the potential health effects associated with lead exposure, the approach outlined in the ALM derives a soil lead concentration that is considered protective of all employees. The foundation for the RBC calculation is the relationship between the mean soil lead concentration and the blood lead concentration in the developing fetus expressed by the following equation:

$$RBC = \frac{(PbB_{adult,central,goal} - PbB_{adult,0}) * AT}{BKSF * IR * AF * EF}$$

Where:

RBC = Risk-Based Concentration

The following table presents the ALM default parameters:

Exposure Variable	Description of Exposure Variable	Units	Value	Rationale/Source
$PbB_{fetal, 0.95}$	95th percentile fetal blood lead concentration	µg/dL	10	EPA 2003
$R_{fetal/maternal}$	Fetal/maternal blood lead concentration	--	0.9	EPA 2003
BKSF	Biokinetic slope factor	µg/dL per µg/day	0.4	EPA 2003
GSD_i	Geometric standard deviation blood lead concentration	--	1.8	Updated from analysis of NHANES
$PbB_{adult,0}$	Adult baseline blood lead concentration	µg/dL	1.00	Updated from analysis of NHANES
IR	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.05	PADEP 2013, EPA 2003
AF	Oral absorption of lead in soil	--	0.12	Based on absorption factor of soluble lead of 0.2 and soil matrix effect of 0.6 (EPA 2003)
EF	Exposure frequency	days/yr	Receptor-specific	Best Professional Judgment
AT	Averaging time	days/yr	Receptor-specific	Best Professional Judgment

Consistent with the approach designated by the PADEP (PADEP, 2013a) and the EPA (EPA, 2003), Langan will use the ALM to derive lead RBCs for industrial worker populations with the most current background blood lead level and geometric standard deviation parameter made available from the 1999-2004 National Health and Nutrition Examination Survey (CDC, 2005).

Centers for Disease Control and Prevention (CDC). 2005. National Center for Health Statistics. *National Health and Nutrition Examination Survey Data*. Hyattsville, MD.

Pennsylvania Department of Environmental Protection (PADEP). 1997. *Appendix A, Table 7, Default Values for Calculating Medium-Specific Concentrations for Lead*. Pennsylvania's Land Recycling Program Technical Guidance Manual. §250.203. August 15, 1997.

PADEP. 2013. *Land Recycling Program Technical Guidance Manual, General Guidance*. December, 2013.

PADEP, 2013a, *Philadelphia Refinery AOI-6 Report Comments*, C. David Brown, November 22, 2013.

Personal Communication. 2010. – (T) based on conversation between James Oppenheim of Sunoco and Hon Lee of the EPA in November 2010.

United States Environmental Protection Agency (USEPA). 2001. *Evaluation of Models for Assessing Human Health Risks Associated with Lead Exposures at Non-Residential Areas of Superfund and Other Hazardous Waste Sites*. EPA-OSWER #9285.7-46. Office of Solid Waste and Emergency Response. Washington, DC. August 2001.

USEPA. 2003. *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.* EPA-540-R-03-001. Technical Review Workgroup for Lead. Washington, DC. January 2003.

Wixson, B.G., (1991). The Society of Environmental Geochemistry and Health (SEGH) Task Force Approach to the Assessment of Lead in Soil. Trace Substances in Environmental Health. 11-20.